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RESEARCH PAPER

Effect of Organics and Spacing on the Growth, Yield and Economics of Brahmi (*Bacopa monnieri*) in Coastal Part of West Bengal

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ABSTRACT

The field experiment was conducted at the Instructional Farm, School of Agriculture and Allied Sciences, The Neotia University, South 24 Parganas, West Bengal, during the *kharif* season of 2023 to study the effects of organics and spacing on the growth attributes, yield attributes, yield and economics of brahmi. Key soil characteristics include sand (58.89%), silt (21.64%) and clay (20.03%) in the top 15 cm layer. The soil's chemical composition includes a *pH* of 7.43, electrical conductivity (*EC*) of 0.62 dS m^{-1} and nutrient levels such as 368 kg ha^{-1} of available nitrogen, 25.75 kg ha^{-1} of available P_2O_5 and 323 kg ha^{-1} of exchangeable K and 0.36% organic carbon. The experiment was laid out in a split plot design, replicated thrice, including four levels of organics (M_1: 2T Cow dung compost /ha, M_2: 2T Cow dung compost/ha + Jeevamruta, M_3: 3T Cow dung compost/ha, M_4: 3T Cow dung compost/ha + Jeevamruta) and four spacings (S_1: 20 × 10 cm, S_2: 20 × 20 cm, S_3: 30 × 10 cm, S_4: 30 × 20 cm). Results indicated that the highest plant height (36.21 cm), dry matter accumulation (181.45 g m^{-2}), Leaf Area Index (0.87) and Crop Growth Rate (3.34 g m^{-2} day^{-1}) were observed with 3T Cow dung compost/ha + Jeevamruta. Application of 3T Cow dung compost/ha + Jeevamruta also recorded maximum number of rooted slips (879.41 m^{-2}), dry wt. of leafy twigs with roots (234.20 g m^{-2}) and green herb yield (183.16 q ha^{-1}) of brahmi. Among the spacing's 30 × 20 cm spacing *i.e.* S_4 recorded highest number of rooted slips (748.66 m^{-2}), dry wt. of leafy twigs with roots (215.95 g m^{-2}) and green herb yield (146.86 q ha^{-1}).

HIGHLIGHTS

- Application of 3T Cow dung compost/ha + Jeevamruta recorded higher values of all the growth attributes, yield attributes and yield of brahmi.
- Spacing of 30 × 20 cm is beneficial for brahmi cultivation

Keywords: Organic nutrient management, *Bacopa monnieri*, Green herb yield, Jeevamruta

Brahmi *(Bacopa monnieri)* comes from the Scrophulariaceae family and is considered as the perennial creeping herb having 64 chromosomes. The suitable temperature is 30-40°C and the suitable area is wet and marshy land for growing Brahmi plants (Tamboli *et al.* 2022). *Bacopa monnieri* is an ancient medicinal herb contains several vitamins, minerals and essential amino acids. Brahmi contains several essential chemical constituents *i.e.* Bacoside A and B, saponins, glycosides, nicotine and brahmine (Mishra *et al.* 2021). Such chemicals are useful to treat various cardiovascular diseases and cognitive function as well as enhancing

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memory. The crop provides an option for the farmers for proper utilization of unused marshy waterlogged lands and that may enhance the food and nutritional security of the country. Uncontrolled use of herbicides causes destruction of native vegetables that promotes soil erosion, dramatic drop in water levels in rivers, canals and irrigation canals, or addition of sewage to rivers has resulted in degradation of biodiversity (Das *et al.* 2008). Advanced agricultural practices can solve those challenges by increasing organic crop production.

Brahmi has a well-known connection with the ancient Indian Ayurvedic world. The plant is famous for its rejuvenating energy and is compared to Brahma who is known as the god of creation (Fatima *et al.* 2022). Since the Vedic period around 3000 years ago, medical experts or ancient sages used to use Brahmi for their ayurvedic treatment (Gupta *et al.* 2021). This plant has a lot of health benefits identified a long time ago by the sages of India. There, the name of *Bacopa monnieri* is found in great ancient books such as *'Sushruta Samhita'* and *'Charaka Samhita'*.

Recent financial statistic represents the export value of Indian Ayurvedic and herbal products have grown considerably from around 354 million dollars in 2015 to 628 million dollars in 2023 (Statista, 2023). It indicates that there is a high demand for medicinal herbs like Brahmi in the Indian market to export various ayurvedic and herbal products.

This herb also contains some medical properties that are proven to cure various nerve diseases and cognitive functions of human beings (Valotto *et al.* 2024). In India, Various pharmaceutical companies use the extract of Brahmi to prepare different medicines. There is also a great demand for *Bacopamonnieri* in the medical and pharmaceutical industries throughout the world.

Application of organic nutrients ensures high quality of brahmi and the demand of brahmi in national and international market is increasing (Smitha *et al*. 2021) Based on its use, the Brahmi market is segmented into food and beverage, pharmaceutical and personal care. Kumar *et al.* (2022) reported that brahmi has shown potential growth in traditional nutrient management systems. Application of Jeevamrut can increase the accumulation of soil microbes and soil diversity along with improving bulk density of soil. Such soil can thus provide an essential nutrient supply to *Bacopa monnieri* in an effective way. Different research studies proved that the application of Jeevamrit, a mixture of soil, cow dung, cow urine, jaggery and gram flour can enhance the nutrient uptake capacity of plants (Pandey *et al.* 2022). Brahmi has shown great results of increased production by using Jeevamrut as compared to other chemical fertilizers or organic manures. Application of vermicompost, FYM and mixed compost performed better growth and yield of brahmi (Singh and Mallick, 2020).

On the other hand, planting of brahmi in proper spacing is important for the farmers to get maximum profit. Because of its limited period for cultivation and high seedling mortality during the two-leaved stage, an effective spacing of brhami is required to get maximum yield (Sanyal *et al.* 2022). Additionally, several other studies also revealed that effective spacing and nutrition are necessary for brahmi production to reach its peak.

Therefore, in order to meet the growing demand for ayurvedic products and to enhance the production of green herb of brahmi, it is necessary to determine the proper dose of organic manure and spacing for the maximum production of brahmi.

MATERIALS AND METHODS

The field experiment took place at the Instructional Farm, School of Agriculture and Allied Sciences, The Neotia University Sarisha, Jhinga, South 24 Parganas, West Bengal, during the Kharif season from September to December 2023. The experimental site is situated at approximately 22.262309° N latitude and 88.196667° E longitude, with an elevation above 9 m mean sea level (MSL) (Approximately). The soil of the experimental field is a medium-textured new alluvial inceptisol with a loam texture and moderate water holding capacity. Key soil characteristics include sand (58.89%), silt (21.64%) and clay (20.03%) in the top 15 cm layer. The soil's chemical composition includes a *pH* of 7.43, electrical conductivity (EC) of 0.62 dS m^{-1}, and nutrient levels such as 368 kg ha^{-1} of available nitrogen, 25.75 kg ha^{-1} of available P_2O_5 and 323 kg ha^{-1} of exchangeable K and 0.36% organic carbon.

The experiment focused on studying the effect of organics and spacing on finger millet growth and yield. It was designed in a split plot format with

organic levels M_1: 2T Cow dung compost /ha, M_2: 2T Cow dung compost/ha + Jeevamruta, M_3: 3T Cow dung compost/ha, M_4: 3T Cow dung compost/ha + Jeevamruta, as main plots and spacing S_1: 20 × 10 cm, S_2: 20 × 20 cm, S_3: 30 × 10 cm, S_4: 30 × 20 cm as subplots. The crop variety used was Pragyashakti (CIMAP, Lucknow), All the compost was applied at the time of final land preparation as basal dose, Jeevamruta was applied as foliar spray at 15 days' interval from planting up to harvesting and irrigation was applied at 50 mm per irrigation, about five times during the growing season. The observations were recorded form 10 randomly selected plants. The data were subjected to statistical analysis using analysis of variance method (Gomez and Gomez, 1984) and the significance of different sources of variations were tested by error mean square using Fisher and Snedecor's 'F" test at a probability level of 0.05.

RESULTS AND DISCUSSION

A significant variation in plant height was noted among the different organic treatments. The maximum plant height (36.21 cm) was found in M_4 *i.e.* 3T Cow dung compost/ha + Jeevamruta, which differed significantly with, M_3 (32.37 cm) *i.e.* 3T Cow dung compost/ha. and M_2 (30.62 cm) *i.e.* 2T Cow dung compost/ha + Jeevamruta and the lowest plant height (29.50 cm) was observed in M_1 *i.e.* 2T Cow dung compost/ha. Application of higher dose of FYM or compost can increase the plant height of bramhi (Smitha *et al.* 2021). Additionally, S_4 *i.e.* 30 × 20 spacing resulted in the highest plant height (33.46 cm) of brahmi.

Highest dry matter accumulation (181.45 g m^{-2}) of brahmi was recorded by M_4 *i.e.* 3T Cow dung compost/ha + Jeevamruta at harvest, which differed significantly from all other treatments. M_3 *i.e.* 3T Cow dung compost/ha recorded a dry matter accumulation of (142.01 g m^{-2}) followed by M_2 i.e. 2T Cow dung compost/ha + Jeevamruta (122.68 g m^{-2}) and the lowest dry matter accumulation (98.76 g m^{-2}) was recorded by M_1*i.e.* 2T Cow dung compost/ha. The percentage increase of M_4 over M_3, M_2 and M_1 were 27.77%, 47.90% and 83.72%, respectively. 30 × 20 cm spacing *i.e.* S_4 achieved the highest dry matter accumulation (148.16 g m^{-2}).

The highest LAI (0.87) was found in M_4 *i.e.* 3T Cow dung compost/ha + Jeevamruta which differed significantly with, M_3 (0.81) *i.e.* 3T Cow dung compost/ha, M_2 (0.66) *i.e.* 2T Cow dung compost/ha + Jeevamruta. The lowest LAI (0.58) was observed in M_1*i.e.* 2T Cow dung compost/ha. Among the spacing, S_4 *i.e.* 30 × 20 cm recorded highest LAI (0.86) of brahmi and differed significantly from other treatments (Table 1).

Table 1: Effect of organics and spacing on the growth attributes of brahmi

Treatments	Plant height (cm)			Dry matter accumulation (g m^{-2})			Leaf area index (LAI)			Crop growth rate (g m^{-2} day^{-1})		
	30 DAT	60 DAT	At Harvest	30 DAT	60 DAT	At Harvest	30 DAT	60 DAT	At Harvest	0-30 DAT	30-60 DAT	60 DAT-At Harvest
(I) Organics												
M_1	11.67	24.16	29.50	21.50	56.50	98.76	0.15	0.50	0.58	0.71	1.16	1.47
M_2	12.25	25.85	30.62	30.20	92.70	122.68	0.17	0.59	0.66	1.00	2.08	2.00
M_3	14.29	27.10	32.37	40.58	111.71	142.01	0.24	0.77	0.81	1.35	2.37	2.57
M_4	15.95	29.77	36.21	66.08	142.91	181.45	0.33	0.84	0.87	2.20	2.56	3.34
S. Em (±)	0.070	0.081	0.112	0.226	0.662	0.442	0.001	0.002	0.001	0.007	0.018	0.015
C. D. (p=0.05)	0.240	0.280	0.388	0.783	2.291	1.532	0.004	0.008	0.004	0.026	0.064	0.054
C.V.	6.120	3.64	4.18	6.86	7.87	3.90	7.48	4.27	2.05	6.86	10.93	8.07
(II) Spacing												
S_1	12.83	26.04	31.00	32.95	85.50	126.51	0.19	0.56	0.61	1.09	1.75	2.05
S_2	13.26	26.45	31.87	38.08	102.00	131.89	0.21	0.63	0.67	1.26	2.13	2.16
S_3	13.83	26.75	32.37	40.41	105.91	138.34	0.23	0.73	0.77	1.34	2.18	2.43
S_4	14.25	27.65	33.46	46.91	110.41	148.16	0.26	0.82	0.86	1.56	2.11	2.75
S. Em (±)	0.061	0.107	0.146	0.292	0.550	0.344	0.001	0.003	0.003	0.009	0.016	0.018
C. D. (p=0.05)	0.177	0.312	0.428	0.854	1.605	1.005	0.004	0.009	0.010	0.028	0048	0.053
C.V.	5.391	4.81	5.46	8.87	6.53	3.03	7.52	5.82	5.64	8.87	9.76	9.38

M_1- 2T Cow dung compost /ha, M_2- 2T Cow dung compost/ha + Jeevamruta, M_3- 3T Cowdung compost/ha, M_4- 3T Cow dung compost/ha + Jeevamruta, S_1 - 20×10 cm., S_2 - 20×20 cm., S_3 - 30×10 cm. and S_4 - 30×20 cm.

The highest CGR (3.34 g m^{-2} day^{-1}) was found in M_4, *i.e.* application of 3T Cow dung compost/ha + Jeevamruta, which significantly differed from all other organic treatments followed by of 3T Cow dung compost/ha (M_3) at 2.57 g m^{-2} day^{-1}, 2T Cow dung compost/ha + Jeevamruta (M_2) at 2.00 g m^{-2} day^{-1} and the lowest CGR is observed with 2T Cow dung compost/ha (M_1) at 1.47 g m^{-2} day^{-1}.

The application of organics significantly influenced the yield attributes and yield of brahmi. The highest number of rooted slips (879.41 m^2), dry wt. of leafy twigs with roots (234.20 g m^{-2}) and green herb yield (183.16 q ha^{-1})were obtained by M_4 (3T Cow dung compost/ha + Jeevamruta). Among the spacing, highest number of rooted slips (748.66 m^2), dry wt. of leafy twigs with roots (215.95 g m^{-2}) and green herb yield (146.86 q ha^{-1}) were recorded by S_4 *i.e.* 30 × 20 cm (Table 2).

The application of Jeevamruta enhances soil nutrient content, improves bulk density and biodiversity by increasing beneficial soil microbes, thereby improving the productivity of Brahmi (Kumar *et al.* 2022). The application of cow dung compost helped *brahmi* to produce better branching and faster elongation of prostrate branches, confirming the findings of Shirole *et al.* (2005) and Baruah *et al.* (2014).

The maximum cost of cultivation (₹ 124625 ha^{-1}), gross return of (₹ 457900 ha^{-1}), net return (₹ 333275 ha^{-1}) and cost: benefit ratio (1: 3.67) were recorded by M_4 *i.e.* application of 3T Cow dung compost/ha + Jeevamruta. Among the spacing, highest cost of cultivation (₹ 103800 ha^{-1}) was recorded by 20 × 10 cm spacing *i.e.* S_1 but highest gross return (₹ 514010 ha^{-1}), net return (₹ 417010 ha^{-1}) and cost: benefit ratio (1: 5.29) were recorded by treatment S_4 *i.e.* 30 × 20 cm.

CONCLUSION

Brahmi is an ancient medicinal herb containing several vitamins, minerals and essential amino acids and useful to treat various cardiovascular diseases and cognitive function as well as enhancing memory. Uncontrolled use of herbicides causes destruction of native vegetables *i.e.* brahmi and promotes soil erosion. Application of 3T cow dung compost/ha + jeevamruta recorded higher values of all the growth attributes, yield attributes and yield of brahmi. The treatment also recorded highest gross return of (₹ ha^{-1}), net return (₹ ha^{-1}) and cost: benefit ratio of brahmi. A spacing of 30 × 20 cm is beneficial for getting maximum yield (q ha^{-1})

Table 2: Effect of organics and spacing on the yield attributes, yield and economics of brahmi

Treatments	No. of rooted slips (m^{-2})	Dry wt. of leafy twigs with roots (g m^{-2})	Green herb yield (q ha^{-1})	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	Cost: Benefit ratio
(I) Organics							
M_1	554.83	172.84	88.22	111000	220550	109550	1: 1.98
M_2	685.66	211.44	108.96	114625	272400	157775	1: 2.37
M_3	781.50	219.36	132.15	121000	330375	209375	1: 2.73
M_4	879.41	234.20	183.16	124625	457900	333275	1: 3.67
S. Em (±)	1.244	0.508	0.704	—	—	—	—
C. D. (*p=0.05*)	4.305	1.757	2.438	—	—	—	—
(II) Spacing							
S_1	695.08	201.40	113.89	103800	398615	294815	1: 3.84
S_2	724.91	208.31	121.12	102200	423920	321720	1: 4.14
S_3	726.75	212.18	130.62	99400	457170	357770	1: 4.60
S_4	748.66	215.95	146.86	97000	514010	417010	1: 5.29
S. Em (±)	1.410	0.382	0.709	—	—	—	—
C. D. (*p=0.05*)	4.117	1.114	2.070	—	—	—	—

M_1- 2T Cow dung compost /ha, M_2- 2T Cow dung compost/ha + Jeevamruta, M_3- 3T Cowdung compost/ha, M_4- 3T Cow dung compost/ha + Jeevamruta, S_1 - 20×10 cm., S_2 - 20×20 cm., S_3 - 30×10 cm. and S_4 - 30×20 cm.

of brahmi. The research findings will enable the farmers to get maximum profit by applying proper dose of manure and proper spacing.

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